

PATENT ABSTRACTS OF JAPAN

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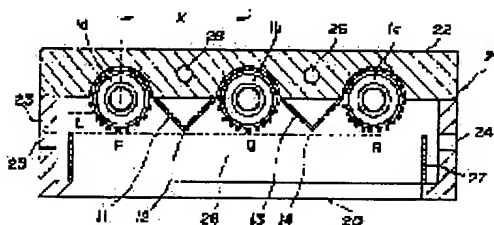
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(54) DIELECTRIC BARRIER DISCHARGE LAMP DEVICE

(57)Abstract:

PURPOSE: To sufficiently improve the irradiation just under discharge lamps, so as to make high efficiency and high reliability by preventing the illuminance distribution from being made uneven with the elapsed lighting time, by providing approximately V-shaped light reflecting plates between mutually adjacent discharge lamps.

CONSTITUTION: V-shaped light reflecting plates 11, 13 constituted by bending an aluminum plates are provided between cylindrical dielectric barrier discharge lamps 1a, 1b and between 1b and 1c. The vertexes 12, 14 of these plates 11, 13 are positioned on a common tangent PQR on the peripheries of the lamps 1a, 1b, 1c facing a light take-out window 20. The space 26 between the lamps 1a, 1b, 1c and the window 20 is filled with gaseous nitrogen injected from an inert gas introducing port 24. Since the vacuum ultraviolet ray is not absorbed by the space 26, the total vacuum ultraviolet ray discharged from respective lamps is discharged from the window 20, and the window 20 substantially forms a rectangular vacuum ultraviolet ray beam. Accordingly, the light taking-out efficiency is improved, and the uniform irradiated surface can be obtained.



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TECHNICAL FIELD

[Industrial Application] this invention is a kind of the ultraviolet line light source equipment for photochemical reaction, forms an excimer molecule by dielectric barrier electric discharge, and relates to improvement of the dielectric barrier discharge lamp equipment which used the so-called dielectric barrier discharge lamp using the light emitted from this excimer molecule, for example, the dry cleaning equipment of a silicon wafer etc.

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PRIOR ART

[Description of the Prior Art] the gas for electric discharge which there is a Japan public presentation patent official report common No. 301357 [four to], and forms an excimer molecule there as technology relevant to this invention at an electric discharge container -- being filled up -- dielectric barrier electric discharge (alias ozonizer electric discharge or silent discharge.) An excimer molecule is made to form by refer to the 263rd page of the reprint 7 ***** in Institute of Electrical Engineers of Japan issue amendment new edition "electric discharge handbook" June, Heisei 1. The lamp using the light emitted from this excimer molecule, i.e., a dielectric barrier discharge lamp, is indicated. This electric discharge container is a cylinder-like, some these electric discharge containers [at least] serve as the dielectric of this dielectric barrier electric discharge, this dielectric is light-transmission nature and the cylinder-like dielectric barrier discharge lamp of this dielectric in which the metal grid was prepared in part at least is indicated. Moreover, the dielectric barrier discharge lamp equipment which put these two or more cylinder-like dielectric barrier discharge lamps in order in parallel is also indicated.

[0003] Drawing 5 which is the schematic diagram of a cylinder-like dielectric barrier discharge lamp is used hereafter, and the outline of general dielectric barrier electric discharge is explained. The electric discharge container 1 is glass [which is a dielectric], arranges the inside pipe 2 and the outside pipe 3 on the same axle, and makes them the shape of a hollow cylinder. The inside electrode 5 for dielectric barrier electric discharge which served as the light reflex film which the ground electrode 4 for dielectric barrier electric discharge of optical permeability formed in the superficies of the inside pipe 2 by the vacuum evaporatio of aluminum is formed in the superficies of the outside pipe 3, respectively. Moreover, the getter room 6 which contains a getter 7 is established in the end of the electric discharge container 1. A getter 7 removes the impure gas (for example, H₂ O etc.) in discharge space 8, and has the function which carries out electric discharge to stability. Discharge space 8 is formed between the internal surfaces of the inside pipe 2 which met the internal surface and electrode 5 of the outside pipe 3 which met the electrode 4. If it is filled up with the gas for electric discharge which forms an excimer molecule by dielectric barrier electric discharge and voltage is impressed to electrodes 4 and 5 by AC power supply 10, dielectric barrier electric discharge will occur stably in discharge space 8, and excimer light will be emitted to discharge space 8.

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EFFECT OF THE INVENTION

[Effect of the Invention] According to this invention, the following effect can be acquired as explained above. The electric discharge container of the light-transmission nature whose appearance is an outline cylinder-like at least in invention of the claim 1 of this invention, The metal grid prepared in some [at least] perimeters of the external surface of this electric discharge container, The inside electrode prepared inside this metal grid at this electric discharge container and the outline same axle, The cylinder-like dielectric barrier discharge lamp which consists of gas for electric discharge with which it fills up in this electric discharge container, and which forms an excimer molecule by dielectric barrier electric discharge, The lamp house which has the optical ejection aperture which takes out the excimer light which arranges these two or more cylinder-like dielectric barrier discharge lamps in parallel, contains them, and is emitted from this excimer molecule, In dielectric barrier discharge lamp equipment equipped with the power supply for performing dielectric barrier electric discharge, it was made the composition which formed the outline V character type light reflex board between these adjoining cylinder-like dielectric barrier discharge lamps. Therefore, optical ejection efficiency can offer the dielectric barrier discharge lamp equipment which can acquire a uniform irradiation side highly.

[0025] In invention of the claim 2 of this invention, in invention of the claim 1 of this invention, since the distance X between the medial axes of this adjoining cylinder-like dielectric barrier discharge lamp was constituted in 3.5 or less times of the diameter D of this cylinder-like dielectric barrier discharge lamp, in addition to the advantage of invention of the claim 1 of this invention, the dielectric barrier discharge lamp equipment with which high irradiance is obtained can be offered.

[0026] In invention of the claim 3 of this invention, it sets to invention of a claim 1 or a claim 2. In the range L on the basis of the common tangent of the periphery of this adjoining cylinder-like dielectric barrier discharge lamp that met this optical ejection aperture, are right-angled to both of the tube axis of this tangent and this cylinder-like dielectric barrier discharge lamp. It constituted so that the peak of this V character type light reflex board might exist in the direction which keeps away from this optical ejection aperture within the limits of L, when it considered as the range of 25% of length of the diameter of this cylinder-like dielectric barrier discharge lamp. Therefore, the advantage of invention of a claim 1 or a claim 2 can offer the dielectric barrier discharge lamp equipment which can be demonstrated further.

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 TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] Since the above cylinder-like dielectric barrier discharge lamps have the various features which are not in a conventional low voltage glow discharge lamp or a conventional arc discharge lamp, they are useful. Since an electric discharge container is made into the shape of an outline cylinder, a commercial glass tube, a ceramic pipe, etc. can be diverted if it is made the structure which prepared the inside electrode inside this electric discharge container at this electric discharge container and the outline same axle, and structure also becomes easy especially, manufacture becomes easy, therefore the advantage that a cylinder-like dielectric barrier discharge lamp can be offered cheaply arises. Therefore, the dielectric barrier discharge lamp equipment which put these two or more cylinder-like dielectric barrier discharge lamps in order in parallel, and formed the substantial flat-surface light source has the advantage that the flat-surface light source can be obtained cheaply.

[0005] However, this invention person etc. discovered experimentally that there were the following faults to the dielectric barrier discharge lamp equipment which used the cylinder-like dielectric barrier discharge lamp which used the conventional metal network electrode. That is, in the dielectric barrier discharge lamp equipment which arranged in two or more parallel the cylinder-like dielectric barrier discharge lamp which used the metal network electrode, the measurement result of a luminous-intensity-distribution distribution of the irradiance on this optical ejection window surface in the pars intermedia of an adjoining dielectric barrier discharge lamp of this one dielectric barrier discharge lamp was understood are more remarkably [than the predicted value piled up and obtained about an adjoining lamp] low. Furthermore, in directly under [of the pars intermedia of the dielectric / with which lighting time passes / barrier discharge lamp with which the rate of a fall of this irradiance adjoins as compared with directly under / of this cylinder-like dielectric barrier discharge lamp / (transverse plane) although it is alike, therefore degradation of the permeability of this glass for electric discharge containers etc. becomes a cause and irradiance falls] (transverse plane), it was remarkable. That is, the disadvantageous point said that an irradiance distribution becomes uneven arose as lighting time passed. In the dielectric barrier discharge lamp equipment with which the main wavelength of excimer light used the dielectric barrier discharge lamp 200nm or less, the above-mentioned fault was especially large.

[0006] The above-mentioned cause is considered to be as follows. That is, when a cylinder-like dielectric barrier discharge lamp is put in order in parallel, it is the first cause that a part of excimer light emitted from the dielectric barrier discharge lamp is absorbed by the metal network electrode of the adjoining cylinder-like dielectric barrier discharge lamp. Although it has been improved to some extent by improving the reflection factor of this metal network electrode by the above-mentioned fault, the large dissolution was impossible by a part of reflected excimer light performing a multiple echo by this metal network electrode, or penetrating the glass which is this electric discharge container many times etc.

[0007] The second cause is considered to be as follows. The front face of this metal network electrode oxidizes, or contamination generates it as lighting time passes. Moreover, dust collects on the mesh of this metal network electrode. By these contamination, the substantial permeability of an electric discharge container falls and an optical output declines. Since contribution of the reflected light from the dielectric barrier discharge lamp which adjoins in directly under [of the pars intermedia of the dielectric barrier discharge lamp which adjoins to falling in proportion / almost / to the fall of this optical output] is large, the irradiance [directly under] of this cylinder-like dielectric barrier discharge lamp is

considered that irradiance falls more remarkably than decline in the substantial permeability of an electric discharge container.

[0008] The above-mentioned fault is a phenomenon peculiar to the dielectric barrier discharge lamp equipment which put the cylindrical dielectric barrier discharge lamp equipped with the metal network electrode in order in parallel.

[0009] this invention is accomplished based on the above situations. the technical problem The electric discharge container of the light-transmission nature whose appearance is an outline cylinder-like at least, and the metal grid prepared in some [at least] perimeters of the external surface of this electric discharge container, The inside electrode prepared inside this metal grid at this electric discharge container and the outline same axle, The cylinder-like dielectric barrier discharge lamp which consists of gas for electric discharge with which it fills up in this electric discharge container, and which forms an excimer molecule by dielectric barrier electric discharge, The lamp house which has the optical ejection aperture which takes out the excimer light which arranges these two or more cylinder-like dielectric barrier discharge lamps in parallel, contains them, and is emitted from this excimer molecule, In dielectric barrier discharge lamp equipment equipped with the power supply for performing dielectric barrier electric discharge The irradiance [directly under] between these adjoining cylinder-like dielectric barrier discharge lamps is fully high, and it is offering efficient and the dielectric barrier discharge lamp equipment of high reliance with which it takes to the lighting passage of time, and an illumination distribution's does not become uneven.

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MEANS

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, it is invention of the claim 1 of this invention. The electric discharge container of the light-transmission nature whose appearance is an outline cylinder-like at least, and the metal grid prepared in some [at least] perimeters of the external surface of this electric discharge container, The inside electrode prepared inside this metal grid at this electric discharge container and the outline same axle, The cylinder-like dielectric barrier discharge lamp which consists of gas for electric discharge with which it fills up in this electric discharge container, and which forms an excimer molecule by dielectric barrier electric discharge, The lamp house which has the optical ejection aperture which takes out the excimer light which arranges these two or more cylinder-like dielectric barrier discharge lamps in parallel, contains them, and is emitted from this excimer molecule, In dielectric barrier discharge lamp equipment equipped with the power supply for performing dielectric barrier electric discharge, an outline V character type light reflex board is formed and constituted between these adjoining cylinder-like dielectric barrier discharge lamps.

[0011] Invention of the claim 2 of this invention constitutes the distance X between the medial axes of this adjoining cylinder-like dielectric barrier discharge lamp in invention of the claim 1 of this invention in 3.5 or less times of the diameter D of this cylinder-like dielectric barrier discharge lamp.

[0012] Invention of the claim 3 of this invention is set to invention of either a claim 1 or the claim 2. In the range L on the basis of the common tangent of the periphery of this adjoining cylinder-like dielectric barrier discharge lamp that met this optical ejection aperture, are right-angled to both of the tube axis of this tangent and this cylinder-like dielectric barrier discharge lamp. It constitutes so that the peak of this V character type light reflex board may exist in the direction which keeps away from this optical ejection aperture within the limits of L, when it considers as the range of 25% of length of the diameter of this cylinder-like dielectric barrier discharge lamp.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] this invention is a kind of the ultraviolet line light source equipment for photochemical reaction, forms an excimer molecule by dielectric barrier electric discharge, and relates to improvement of the dielectric barrier discharge lamp equipment which used the so-called dielectric barrier discharge lamp using the light emitted from this excimer molecule, for example, the dry cleaning equipment of a silicon wafer etc.

[0002]

[Description of the Prior Art] the gas for electric discharge which there is a Japan public presentation patent official report common No. 301357 [four to], and forms an excimer molecule there as technology relevant to this invention at an electric discharge container -- being filled up -- dielectric barrier electric discharge (alias ozonizer electric discharge or silent discharge.) An excimer molecule is made to form by refer to the 263rd page of the reprint 7 ***** in Institute of Electrical Engineers of Japan issue amendment new edition "electric discharge handbook" June, Heisei 1. The lamp using the light emitted from this excimer molecule, i.e., a dielectric barrier discharge lamp, is indicated. This electric discharge container is a cylinder-like, some these electric discharge containers [at least] serve as the dielectric of this dielectric barrier electric discharge, this dielectric is light-transmission nature and the cylinder-like dielectric barrier discharge lamp of this dielectric in which the metal grid was prepared in part at least is indicated. Moreover, the dielectric barrier discharge lamp equipment which put these two or more cylinder-like dielectric barrier discharge lamps in order in parallel is also indicated.

[0003] Drawing 5 which is the schematic diagram of a cylinder-like dielectric barrier discharge lamp is used hereafter, and the outline of general dielectric barrier electric discharge is explained. The electric discharge container 1 is glass [which is a dielectric], arranges the inside pipe 2 and the outside pipe 3 on the same axle, and makes them the shape of a hollow cylinder. The inside electrode 5 for dielectric barrier electric discharge which served as the light reflex film which the ground electrode 4 for dielectric barrier electric discharge of optical permeability formed in the superficies of the inside pipe 2 by the vacuum evaporatio of aluminum is formed in the superficies of the outside pipe 3, respectively. Moreover, the getter room 6 which contains a getter 7 is established in the end of the electric discharge container 1. A getter 7 removes the impure gas (for example, H₂ O etc.) in discharge space 8, and has the function which carries out electric discharge to stability. Discharge space 8 is formed between the internal surfaces of the inside pipe 2 which met the internal surface and electrode 5 of the outside pipe 3 which met the electrode 4. If it is filled up with the gas for electric discharge which forms an excimer molecule by dielectric barrier electric discharge and voltage is impressed to electrodes 4 and 5 by AC power supply 10, dielectric barrier electric discharge will occur stably in discharge space 8, and excimer light will be emitted to discharge space 8.

[0004]

[Problem(s) to be Solved by the Invention] Since the above cylinder-like dielectric barrier discharge lamps have the various features which are not in a conventional low voltage glow discharge lamp or a conventional arc discharge lamp, they are useful. Since an electric discharge container is made into the shape of an outline cylinder, a commercial glass tube, a ceramic pipe, etc. can be diverted if it is made the structure which prepared the inside electrode inside this electric discharge container at this electric discharge container and the outline same axle, and structure also becomes easy especially, manufacture becomes easy, therefore the advantage that a cylinder-like dielectric barrier discharge lamp can be offered cheaply arises. Therefore, the dielectric barrier discharge lamp equipment which put these two or more cylinder-like dielectric barrier discharge lamps in order in parallel, and formed the substantial flat-surface light source has the advantage that the flat-surface light source can be obtained cheaply.

[0005] However, this invention person etc. discovered experimentally that there were the following faults to the dielectric barrier discharge lamp equipment which used the cylinder-like dielectric barrier discharge lamp which used the conventional metal network electrode. That is, in the dielectric barrier discharge lamp equipment which arranged in two or more parallel the cylinder-like dielectric barrier discharge lamp which used the metal network electrode, the measurement result of a luminous-intensity-distribution distribution of the irradiance on this optical ejection window surface in the pars intermedia

of an adjoining dielectric barrier discharge lamp of this one dielectric barrier discharge lamp was understood are more remarkably [than the predicted value piled up and obtained about an adjoining lamp] low. Furthermore, in directly under [of the pars intermedia of the dielectric / with which lighting time passes / barrier discharge lamp with which the rate of a fall of this irradiance adjoins as compared with directly under / of this cylinder-like dielectric barrier discharge lamp / (transverse plane) although it is alike, therefore degradation of the permeability of this glass for electric discharge containers etc. becomes a cause and irradiance falls] (transverse plane), it was remarkable. That is, the disadvantageous point said that an irradiance distribution becomes uneven arose as lighting time passed. In the dielectric barrier discharge lamp equipment with which the main wavelength of excimer light used the dielectric barrier discharge lamp 200nm or less, the above-mentioned fault was especially large.

[0006] The above-mentioned cause is considered to be as follows. That is, when a cylinder-like dielectric barrier discharge lamp is put in order in parallel, it is the first cause that a part of excimer light emitted from the dielectric barrier discharge lamp is absorbed by the metal network electrode of the adjoining cylinder-like dielectric barrier discharge lamp. Although it has been improved to some extent by improving the reflection factor of this metal network electrode by the above-mentioned fault, the large dissolution was impossible by a part of reflected excimer light performing a multiple echo by this metal network electrode, or penetrating the glass which is this electric discharge container many times etc.

[0007] The second cause is considered to be as follows. The front face of this metal network electrode oxidizes, or contamination generates it as lighting time passes. Moreover, dust collects on the mesh of this metal network electrode. By these contamination, the substantial permeability of an electric discharge container falls and an optical output declines. Since contribution of the reflected light from the dielectric barrier discharge lamp which adjoins in directly under [of the pars intermedia of the dielectric barrier discharge lamp which adjoins to falling in proportion / almost / to the fall of this optical output] is large, the irradiance [directly under] of this cylinder-like dielectric barrier discharge lamp is considered that irradiance falls more remarkably than decline in the substantial permeability of an electric discharge container.

[0008] The above-mentioned fault is a phenomenon peculiar to the dielectric barrier discharge lamp equipment which put the cylindrical dielectric barrier discharge lamp equipped with the metal network electrode in order in parallel.

[0009] this invention is accomplished based on the above situations. the technical problem The electric discharge container of the light-transmission nature whose appearance is an outline cylinder-like at least, and the metal grid prepared in some [at least] perimeters of the superficies of this electric discharge container, The inside electrode prepared inside this metal grid at this electric discharge container and the outline same axle, The cylinder-like dielectric barrier discharge lamp which consists of gas for electric discharge with which it fills up in this electric discharge container, and which forms an excimer molecule by dielectric barrier electric discharge, The lamp house which has the optical ejection aperture which takes out the excimer light which arranges these two or more cylinder-like dielectric barrier discharge lamps in parallel, contains them, and is emitted from this excimer molecule, In dielectric barrier discharge lamp equipment equipped with the power supply for performing dielectric barrier electric discharge The irradiance [directly under] between these adjoining cylinder-like dielectric barrier discharge lamps is fully high, and it is offering efficient and the dielectric barrier discharge lamp equipment of high reliance with which it takes to the lighting passage of time, and an illumination distribution's does not become uneven.

[0010]

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, invention of the claim 1 of this invention The electric discharge container of the light-transmission nature whose appearance is an outline cylinder-like at least, and the metal grid prepared in some [at least] perimeters of the superficies of this electric discharge container, The inside electrode prepared inside this metal grid at this electric discharge container and the outline same axle, The cylinder-like dielectric barrier discharge lamp which consists of gas for electric discharge with which it fills up in this electric discharge container, and which forms an excimer molecule by dielectric barrier electric discharge, The lamp house which has the optical ejection aperture which takes out the excimer light which arranges

these two or more cylinder-like dielectric barrier discharge lamps in parallel, contains them, and is emitted from this excimer molecule, In dielectric barrier discharge lamp equipment equipped with the power supply for performing dielectric barrier electric discharge, an outline V character type light reflex board is formed and constituted between these adjoining cylinder-like dielectric barrier discharge lamps.

[0011] Invention of the claim 2 of this invention constitutes the distance X between the medial axes of this adjoining cylinder-like dielectric barrier discharge lamp in invention of the claim 1 of this invention in 3.5 or less times of the diameter D of this cylinder-like dielectric barrier discharge lamp.

[0012] Invention of the claim 3 of this invention is set to invention of either a claim 1 or the claim 2. In the range L on the basis of the common tangent of the periphery of this adjoining cylinder-like dielectric barrier discharge lamp that met this optical ejection aperture, are right-angled to both of the tube axis of this tangent and this cylinder-like dielectric barrier discharge lamp. It constitutes so that the peak of this V character type light reflex board may exist in the direction which keeps away from this optical ejection aperture within the limits of L, when it considers as the range of 25% of length of the diameter of this cylinder-like dielectric barrier discharge lamp.

[0013]

[Function] The electric discharge container of the light-transmission nature whose appearance is an outline cylinder-like at least in invention of the claim 1 of this invention, The metal grid prepared in some [at least] perimeters of the superficies of this electric discharge container, The inside electrode prepared inside this metal grid at this electric discharge container and the outline same axle, The cylinder-like dielectric barrier discharge lamp which consists of gas for electric discharge with which it fills up in this electric discharge container, and which forms an excimer molecule by dielectric barrier electric discharge, The lamp house which has the optical ejection aperture which takes out the excimer light which arranges these two or more cylinder-like dielectric barrier discharge lamps in parallel, contains them, and is emitted from this excimer molecule, Since it was made the composition which formed the outline V character type light reflex board between these adjoining cylinder-like dielectric barrier discharge lamps in dielectric barrier discharge lamp equipment equipped with the power supply for performing dielectric barrier electric discharge The excimer light which goes to the dielectric barrier discharge lamp which is emitted from this cylinder-like dielectric barrier discharge lamp, and adjoins Since it is reflected with a this outline V character type light reflex board and goes to this optical ejection aperture The irradiance [directly under] between the dielectric barrier discharge lamps which carrying out direct incidence to an adjoining dielectric barrier discharge lamp, and being absorbed by this metal network electrode is lost, consequently adjoin becomes high enough, and efficient dielectric barrier discharge lamp equipment is obtained.

[0014] In invention of the claim 2 of this invention, in invention of a claim 1, since the distance X between the medial axes of this adjoining cylinder-like dielectric barrier discharge lamp was constituted in 3.5 or less times of the diameter D of this cylinder-like dielectric barrier discharge lamp, the amount of the excimer light which carries out incidence to this optical ejection aperture increases, and, in addition to the effect of a claim 1, the dielectric barrier discharge lamp equipment of high irradiance is obtained. In not forming a this outline V character type light reflex board If the distance X between the medial axes of this adjoining cylinder-like dielectric barrier discharge lamp is constituted in 3.5 or less times of the diameter D of this cylinder-like dielectric barrier discharge lamp The excimer absorption of light by the metal network electrode of an adjoining dielectric barrier discharge lamp becomes remarkably large, consequently the fault that an uneven expansion of decline in optical ejection efficiency and the irradiance distribution taken to the lighting passage of time occurs becomes remarkably large. In addition, the outer diameter D of this cylindrical dielectric barrier discharge lamp in this invention is an outer diameter also including the thickness of the grid measured where an electric discharge container is equipped. for example, when the electric discharge container of a diameter Zmm is equipped with the cylinder-like network which made the strand of a diameter dmm cross, the outer diameter D of a lamp also including the thickness of this conductive grid becomes the sum of 4 times and Z of d due to "the lap boiled and depended from the time's of making a network" of a strand

[0015] In invention of the claim 3 of this invention, it sets to invention of either a claim 1 or the claim 2. In the range L on the basis of the common tangent which met this optical ejection aperture of the

periphery of this adjoining cylinder-like dielectric barrier discharge lamp that met this optical ejection aperture, are right-angled to both of the tube axis of this tangent and this cylinder-like dielectric barrier discharge lamp. Since it constituted so that the peak of this V character type light reflex board might exist in the direction which keeps away from this optical ejection aperture within the limits of L, when it considered as 25% of length of the diameter of this cylinder-like dielectric barrier discharge lamp, an operation of invention of either a claim 1 or the claim 2 is demonstrated more notably. In addition, even if the peak of this V character type light reflex board was extended at this optical ejection aperture side and existed rather than this tangent, the effect which prevents carrying out incidence to this cylinder-like dielectric barrier discharge lamp that the excimer light emitted from the dielectric barrier discharge lamp adjoined did not become large, but the fault that the ejection efficiency of excimer light fell produced it rather. Moreover, if the effect which prevents carrying out incidence to this cylinder-like dielectric barrier discharge lamp that the excimer light emitted from the dielectric barrier discharge lamp adjoined is enough when the peak of this V character type light reflex board exists in the position which kept away from this optical ejection aperture from this range L, there is nothing, and the effect of an improvement of optical ejection efficiency decreased.

[0016]

[Example] The schematic diagram of the dielectric barrier discharge lamp equipment which is the first example of this invention is shown in drawing 1. Drawing 1 is explanatory drawing having shown the cross section seen from [of a cylinder-like dielectric barrier discharge lamp] the tube axis. The cylinder-like dielectric barrier discharge lamps 1a, 1b, and 1c in this example are the same as that of the composition of the lamp of drawing 5, and it is synthetic quartz glass [with an overall length of about 250mm], and the electric discharge container 1 arranges the outside pipe 3 with an outer diameter [of 16mm], the inside pipe 2 with a thickness of 1mm, an outer diameter [of about 26.5mm], and a thickness of 1mm on the same axle, and they make it the The outside pipe 3 is making the dielectric barrier of dielectric barrier electric discharge, and optical ejection window part material serve a double purpose, and the ground electrode 4 which consists of a metal network which penetrates light on the superficies is formed. The length of the direction of a tube axis of a metal network is 200mm. A grid 4 is the cylinder-like network which has elasticity in shaft orientations in a Monel line with a diameter of 0.15mm and which was knit seamlessly, the electric discharge container 1 is inserted into this cylinder-like metal network, and the grid 4 close to the outside of the outside pipe 3 is formed by pulling to the shaft orientations of a lamp. Therefore, the outer diameter D of this cylindrical dielectric barrier discharge lamp is set to about 27.1mm. Moreover, the inside electrode 5 for dielectric barrier electric discharge which served as the light reflex film formed by the vacuum evaporation of aluminum is formed in the superficies of the inside pipe 2. The tube wall of the electric discharge container 1 is extended at the end of the electric discharge container 1, and the getter hold room 6 is established in it. The barium getter 7 which becomes this getter hold room 6 from a barium alloy was contained, high-frequency heating of the barium getter 7 was carried out, and the thin film of barium was formed in the getter hold interior of a room. And discharge space 8 was filled up with the xenon gas of 30kPa(s) as gas for electric discharge.

[0017] The above-mentioned cylinder-like dielectric barrier discharge lamps 1a, 1b, and 1c were contained in the lamp house 21. The airtight lamp house 21 is formed of cooling of a lamp, the cooling block 22 which served both as the light reflex board, the rectangle-like light ejection aperture 20 which the size of opening becomes from the synthetic quartz glass which is 170mmx170mm, and the side plate 23. The paths 28 and 29 of the fluid for cooling are established in the cooling block 22. The distance X between the medial axes of this cylinder-like dielectric barrier discharge lamp 1a, and 1b, 1b and 1c is 60mm. Therefore, the ratio of the distance X between the medial axes of this adjoining cylinder-like dielectric barrier discharge lamp and the outer diameter D of this cylinder-like dielectric barrier discharge lamp is about 2.2.

[0018] The V which are length of 170mm which bent and constituted aluminum plate between cylinder-like dielectric barrier discharge lamp 1a, and b [1], b [1] and 1c character type light reflex boards 11 and 13 were formed. The peaks 12 and 14 of the V character type light reflex boards 11 and 13 are located on the common tangent PQR of the periphery of these cylinder-like dielectric barrier discharge lamps 1a, 1b, and 1c that met this optical ejection aperture 20. The space 26 between these cylinder-like

dielectric barrier discharge lamps 1a, 1b, and 1c and the rectangle-like light ejection aperture 20 is full of the nitrogen gas poured in from the inert gas inlet 24. 25 is a gas exhaust port. The light reflex board 27 with which the size of opening consists of an aluminum plate of the hollow prismatic whose height is 15mm by 170mmx170mm was formed in the circumference of this rectangle-like light ejection aperture 20.

[0019] These cylinder-like dielectric barrier discharge lamps 1a, 1b, and 1c were connected in parallel with the power supply 10 of a piece. When the applied voltage to the lamp which frequency expressed with the voltage between about 13kHz, maximum, and the minimum values set the output of a power supply to about 12kV, these dielectric barrier discharge lamps 1a, 1b, and 1c were turned on by abbreviation 50W, respectively, and the vacuum ultraviolet radiation of the range of wavelength to 180nm wavelength of 160nm which has maximum was emitted to the wavelength of 172nm emitted from the excimer molecule of a xenon. It is reflected by the V character type light reflex boards 11 and 13, the course is changed into the optical ejection aperture 20, and the portion which goes to the dielectric barrier discharge lamp which adjoined among these vacuum ultraviolet radiation is emitted from the optical ejection aperture 20. That is, the ejection efficiency of vacuum ultraviolet radiation increased. In this case, since the space 26 between these cylinder-like dielectric barrier discharge lamps 1a, 1b, and 1c and the optical ejection aperture 20 is full of nitrogen gas as described above, this vacuum ultraviolet radiation is not absorbed in this space 26. Therefore, from the rectangle-like light ejection aperture 20, the sum total of this vacuum ultraviolet radiation emitted from these cylinder-like dielectric barrier discharge lamps 1a, 1b, and 1c is emitted, therefore this rectangle-like light ejection aperture 20 serves as the rectangle-like vacuum-ultraviolet-radiation light source substantially.

[0020] When 150mmx150mm glass was separated from the optical ejection aperture 20 of the dielectric barrier discharge lamp equipment described above in air about 3mm, and was installed and vacuum ultraviolet radiation was irradiated with this dielectric barrier discharge lamp equipment, uniform irradiance was obtained, consequently irradiation of this vacuum ultraviolet radiation to matter other than the glass which is a processed material was able to carry out oxidization removal of the organic contamination on glass uniformly in the few state.

[0021] The second example of this invention is shown in drawing 2. The composition of the cylinder-like dielectric barrier discharge lamps 1a, 1b, and 1c in this example and the optical ejection aperture 20 is the same as that of the first example of this invention, and the distance X between the medial axes of this cylinder-like dielectric barrier discharge lamp 1a, and 1b, 1b and 1c is 60mm. Therefore, the ratio of the distance X between the medial axes of this adjoining cylinder-like dielectric barrier discharge lamp and the diameter D of this cylinder-like dielectric barrier discharge lamp is about 2.2. The V character type light reflex boards 31 and 33 serve as some walls of a lamp house 21, and bend and constitute the aluminum plate of one sheet. Moreover, the position Y of the peaks 32 and 34 of the V character type light reflex boards 31 and 33 is on [from a common tangent PQR] 5mm, and exists in L which is the range in which existence of the peak of this V character type light reflex board is permitted. In addition, L in this example is 6.77mm. In addition to the advantage of the first example, the advantage that structure is easy and it can manufacture cheaply lightweight produces this example.

[0022] In the first example, the light reflex board on the trapezoid shown in drawing 3 which made flatness some noses of cam of V characters instead of the V character type light reflex board is used for the third example of this invention. In addition to the advantage of the first example, in this example, the advantage that processing of a light reflex board is easy arises.

[0023] In the first example, the light reflex board of a shell form shown in drawing 4 which gave ***** near the nose of cam of V characters instead of the V character type light reflex board is used for the fourth example of this invention. In addition to the advantage of the first example, in this example, the advantage that irradiance is made more to homogeneity arises.

[0024]

[Effect of the Invention] According to this invention, the following effect can be acquired as explained above. The electric discharge container of the light-transmission nature whose appearance is an outline cylinder-like at least in invention of the claim 1 of this invention, The metal grid prepared in some [at least] perimeters of the superficies of this electric discharge container, The inside electrode prepared inside this metal grid at this electric discharge container and the outline same axle, The cylinder-like

dielectric barrier discharge lamp which consists of gas for electric discharge with which it fills up in this electric discharge container, and which forms an excimer molecule by dielectric barrier electric discharge, The lamp house which has the optical ejection aperture which takes out the excimer light which arranges these two or more cylinder-like dielectric barrier discharge lamps in parallel, contains them, and is emitted from this excimer molecule, Since it was made the composition which formed the outline V character type light reflex board between these adjoining cylinder-like dielectric barrier discharge lamps in dielectric barrier discharge lamp equipment equipped with the power supply for performing dielectric barrier electric discharge Optical ejection efficiency can offer the dielectric barrier discharge lamp equipment which can acquire a uniform irradiation side highly.

[0025] In invention of the claim 2 of this invention, in invention of the claim 1 of this invention, since the distance X between the medial axes of this adjoining cylinder-like dielectric barrier discharge lamp was constituted in 3.5 or less times of the diameter D of this cylinder-like dielectric barrier discharge lamp, in addition to the advantage of invention of the claim 1 of this invention, the dielectric barrier discharge lamp equipment with which high irradiance is obtained can be offered.

[0026] In invention of the claim 3 of this invention, it sets to invention of a claim 1 or a claim 2. In the range L on the basis of the common tangent of the periphery of this adjoining cylinder-like dielectric barrier discharge lamp that met this optical ejection aperture, are right-angled to both of the tube axis of this tangent and this cylinder-like dielectric barrier discharge lamp. Since it constituted so that the peak of this V character type light reflex board might exist in the direction which keeps away from this optical ejection aperture within the limits of L , when it considered as the range of 25% of length of the diameter of this cylinder-like dielectric barrier discharge lamp The advantage of invention of a claim 1 or a claim 2 can offer the dielectric barrier discharge lamp equipment which can be demonstrated further.

[Translation done.]

CLAIMS

[Claim(s)]

[Claim 1] The electric discharge container of the light-transmission nature whose appearance is an outline cylinder-like. The metal grid prepared in some [at least] perimeters of the external surface of this electric discharge container. The inside electrode prepared inside this metal grid at this electric discharge container and the outline same axle. The cylinder-like dielectric barrier discharge lamp which consists of gas for electric discharge with which it fills up in this electric discharge container, and which forms an excimer molecule by dielectric barrier electric discharge. The lamp house which has the optical ejection aperture which takes out the excimer light which arranges these two or more cylinder-like dielectric barrier discharge lamps in parallel, contains them, and is emitted from this excimer molecule, and the power supply for performing dielectric barrier electric discharge. It is dielectric barrier discharge lamp equipment equipped with the above, and is characterized by making it the composition which formed the outline V character type light reflex board between these adjoining cylinder-like dielectric barrier discharge lamps.

[Claim 2] Dielectric barrier discharge lamp equipment according to claim 1 characterized by constituting the distance X between the medial axes of this adjoining cylinder-like dielectric barrier discharge lamp in 3.5 or less times of the diameter D of this cylinder-like dielectric barrier discharge lamp.

[Claim 3] In the range L on the basis of the common tangent of the periphery of this adjoining cylinder-like dielectric barrier discharge lamp that met this optical ejection aperture, are right-angled to both of the tube axis of this tangent and this cylinder-like dielectric barrier discharge lamp. When it considers as the range of 25% of length of the diameter of this cylinder-like dielectric barrier discharge lamp in the direction which keeps away from this optical ejection aperture, Dielectric barrier discharge lamp equipment given in either the claim 1 characterized by constituting so that the peak of this V character type light reflex board may exist within the limits of L, or the claim 2.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is explanatory drawing of the example of the dielectric barrier discharge lamp equipment of this invention.

[Drawing 2] It is explanatory drawing of other examples of the dielectric barrier discharge lamp equipment of this invention.

[Drawing 3] It is explanatory drawing of the important section of other examples of the dielectric barrier discharge lamp equipment of this invention.

[Drawing 4] It is explanatory drawing of the important section of other examples of the dielectric barrier discharge lamp equipment of this invention.

[Drawing 5] It is explanatory drawing of a cylindrical dielectric barrier discharge lamp.

[Description of Notations]

1 Electric Discharge Container

1a, 1b, 1c Dielectric barrier discharge lamp

2 Inside Pipe

3 Outside Pipe

4 Grid

5 Inside Electrode

6 Getter Hold Room

7 Getter

11 13 V character type light reflex board

12 14 The peak of a V character type light reflex board

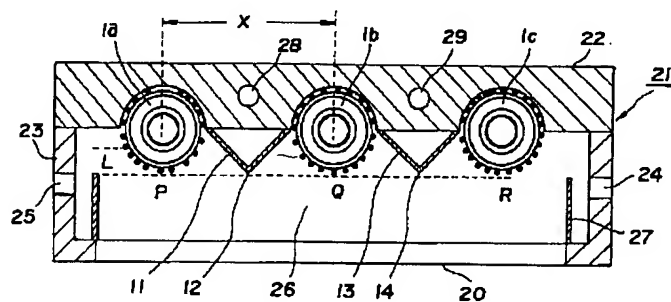
20 Optical Ejection Aperture

21 Lamp House

22 Cooling Block

27 Light Reflex Board

[Translation done.]

Drawing selection 

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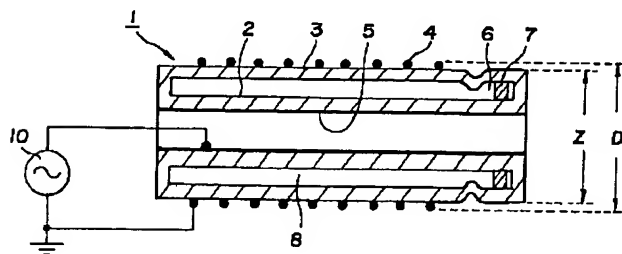


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Drawing selection 



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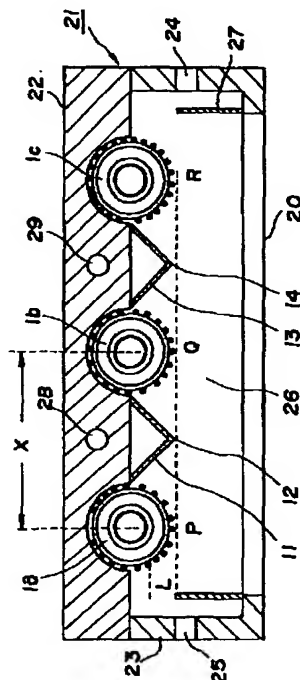
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(54) 【発明の名称】 誘電体バリア放電ランプ装置

(57) 【要約】 (修正有)

【目的】 隣接する円筒状誘電体バリア放電ランプ間の直下の放射照度が十分に高く、かつ、点灯時間の経過に連れて照度分布が不均一にならない高効率、高信頼の誘電体バリア放電ランプ装置を提供する。

【構成】 外形が概略円筒状である光透過性の放電容器と、放電容器の外周の一部の全周に設けた金属網状電極と、金属網状電極の内側に放電容器と概略同軸に設けた内側電極と、放電容器内に充填され、誘電体バリア放電によってエキシマ分子を形成する放電用ガスからなる円筒状誘電体バリア放電ランプ1a~1cと、複数本の前記ランプを並行に配置して収納し、エキシマ分子から放出されるエキシマ光を取り出す光取り出し窓20を有するランプハウスと、誘電体バリア放電を行うための電源を備えた誘電体バリア放電ランプ装置において、隣接した前記ランプの間に概略V字型の光反射板11、13を設ける。



【特許請求の範囲】

【請求項1】 外形が概略円筒状である光透過性の放電容器と、該放電容器の外面の少なくとも一部の全周に設けた金属網状電極と、該金属網状電極の内側に該放電容器と概略同軸に設けた内側電極と、該放電容器内に充填され、誘電体バリア放電によってエキシマ分子を形成する放電用ガスからなる円筒状誘電体バリア放電ランプと、複数本の該円筒状誘電体バリア放電ランプを並行に配置して収納し、該エキシマ分子から放出されるエキシマ光を取り出す光取り出し窓を有するランプハウスと、誘電体バリア放電を行うための電源を備えた誘電体バリア放電ランプ装置において、隣接した該円筒状誘電体バリア放電ランプの間に概略V字型の光反射板を設けた構成にした事の特徴とする誘電体バリア放電ランプ装置。

【請求項2】 隣接した該円筒状誘電体バリア放電ランプの中心軸間の距離Xを該円筒状誘電体バリア放電ランプの直径Dの3.5倍以下に構成した事の特徴とする請求項1に記載の誘電体バリア放電ランプ装置。

【請求項3】 該光取り出し窓に対面した隣接した該円筒状誘電体バリア放電ランプの円周の共通の接線を基準にした範囲Lを、該接線と該円筒状誘電体バリア放電ランプの管軸の両者に直角で、該光取り出し窓から遠ざかる方向に、該円筒状誘電体バリア放電ランプの直径の25%の長さの範囲としたとき、該V字型光反射板の頂点がLの範囲内に存在するように構成した事の特徴とする請求項1または請求項2のいずれかに記載の誘電体バリア放電ランプ装置。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は、例えば、光化学反応用の紫外線光源装置の一種で、誘電体バリア放電によってエキシマ分子を形成し、該エキシマ分子から放射される光を利用するいわゆる誘電体バリア放電ランプを使用した誘電体バリア放電ランプ装置、例えば、シリコンウエハの乾式洗浄装置等の改良に関する。

【0002】

【従来の技術】本発明に関連した技術としては、例えば、日本国公開特許公報平4-301357号があり、そこには、放電容器にエキシマ分子を形成する放電用ガスを充填し、誘電体バリア放電（別名オゾナイザ放電あるいは無声放電。電気学会発行改定新版「放電ハンドブック」平成1年6月再版7刷発行第263ページ参照）によってエキシマ分子を形成せしめ、該エキシマ分子から放射される光を利用するランプ、すなわち誘電体バリア放電ランプについて記載されており、該放電容器は円筒状であり、該放電容器の少なくとも一部は該誘電体バリア放電の誘電体を兼ねており、該誘電体は光透過性であり、該誘電体の少なくとも一部に金属網状電極が設けられた円筒状誘電体バリア放電ランプが記載されてい

る。また、複数本の該円筒状誘電体バリア放電ランプを並行に並べた誘電体バリア放電ランプ装置についても記載されている。

【0003】以下、円筒状誘電体バリア放電ランプの概略図である図5を使用して、一般的な誘電体バリア放電の概要について説明する。放電容器1は誘電体であるガラス製で、内側管2、外側管3を同軸に配置して中空円筒状にしたものである。外側管3の外面には光透過性の誘電体バリア放電用の外側電極4が、内側管2の外面にはアルミニウムの蒸着によって形成した光反射膜を兼ねた誘電体バリア放電用の内側電極5がそれぞれ設けられている。また放電容器1の一端には、ゲッタ7を収納するゲッタ室6が設けられている。ゲッタ7は放電空間8における不純ガス（例えばH₂O等）を除去し、放電を安定にする機能を持つ。電極4に対面した外側管3の内表面と電極5に対面した内側管2の内表面の間には放電空間8が形成される。放電空間8に、誘電体バリア放電によってエキシマ分子を形成する放電用ガスを充填し、交流電源10によって電極4、5に電圧を印加すると、放電空間8に誘電体バリア放電が安定に発生し、エキシマ光が放出される。

【0004】

【発明が解決しようとする課題】上記のような円筒状誘電体バリア放電ランプは、従来の低圧グロー放電ランプやアーク放電ランプには無い種々の特長を有しているため有用である。特に、放電容器を概略円筒状にし、該放電容器の内側に該放電容器と概略同軸に内側電極を設けた構造にすると、市販のガラス管、セラミックス管等を流用する事が出来、かつ、構造も簡単になるので製作が容易になり、従って安価に円筒状誘電体バリア放電ランプを提供できるという利点が生じる。従って、複数本の該円筒状誘電体バリア放電ランプを並列に並べて実質的な平面光源を形成した誘電体バリア放電ランプ装置は、平面光源を安価に得られるという利点がある。

【0005】しかし、本発明者等は、従来の金属網電極を使用した円筒状誘電体バリア放電ランプを使用した誘電体バリア放電ランプ装置には、以下のような欠点があることを実験的に発見した。すなわち、金属網電極を使用した円筒状誘電体バリア放電ランプを複数本並列に並べた誘電体バリア放電ランプ装置においては、隣接する誘電体バリア放電ランプの中間部における該光取り出し窓面上の放射照度が、一本の該誘電体バリア放電ランプの配光分布の測定結果を隣接するランプについて重ね合わせて得られる予想値よりも著しく低いことが判った。さらに、点灯時間が経過するに従って、該放電容器用ガラスの透過率の劣化などが原因となって、放射照度は低下するが、この放射照度の低下の割合は、該円筒状誘電体バリア放電ランプの直下（正面）に比較し、隣接する誘電体バリア放電ランプの中間部の直下（正面）において著しかった。すなわち、点灯時間が経過するに従って

放射照度分布が不均一になると言う不利点が生じた。エキシマ光の中心波長が200nm以下の誘電体バリア放電ランプを使用した誘電体バリア放電ランプ装置においては特に上記の欠点が大きかった。

【0006】上記の原因は以下のようであると思われる。すなわち、円筒状誘電体バリア放電ランプを並行に並べると、誘電体バリア放電ランプから放出されたエキシマ光の一部が、隣接した円筒状誘電体バリア放電ランプの金属網電極に吸収されるのが第一の原因である。上記した欠点は、該金属網電極の反射率を改善することによってある程度改善できたが、反射されたエキシマ光の一部は該金属網電極で多重反射を行ったり、該放電容器であるガラスを多数回透過することなどによって、大幅な解消は不可能であった。

【0007】第二の原因は以下のようであると思われる。点灯時間が経過するに従って、該金属網電極の表面は酸化したり汚染が発生する。また該金属網電極の網目には埃が溜まる。これらの汚染によって放電容器の実質的な透過率が低下し光出力が低下する。該円筒状誘電体バリア放電ランプの直下の放射照度は該光出力の低下にほぼ比例して低下するのに対して、隣接する誘電体バリア放電ランプの中間部の直下においては、隣接する誘電体バリア放電ランプからの反射光の寄与が大きいので、放電容器の実質的な透過率の低下よりも著しく放射照度が低下するものと思われる。

【0008】上記した欠点は、金属網電極を備えた円筒型誘電体バリア放電ランプを並列に並べた誘電体バリア放電ランプ装置に特有の現象である。

【0009】本発明は、以上のような事情に基づいて成されたものであって、その課題は、少なくとも外形が概略円筒状である光透過性の放電容器と、該放電容器の外表面の少なくとも一部の全周に設けた金属網状電極と、該金属網状電極の内側に該放電容器と概略同軸に設けた内側電極と、該放電容器内に充填され、誘電体バリア放電によってエキシマ分子を形成する放電用ガスからなる円筒状誘電体バリア放電ランプと、複数本の該円筒状誘電体バリア放電ランプを並行に配置して収納し、該エキシマ分子から放出されるエキシマ光を取り出す光取り出し窓を有するランプハウスと、誘電体バリア放電を行うための電源を備えた誘電体バリア放電ランプ装置において、隣接する該円筒状誘電体バリア放電ランプ間の直下の放射照度が十分に高く、かつ、点灯時間の経過に連れて照度分布が不均一にならない高効率、高信頼の誘電体バリア放電ランプ装置を提供することである。

【0010】

【問題を解決するための手段】上記課題を解決するため、本発明の請求項1の発明は、少なくとも外形が概略円筒状である光透過性の放電容器と、該放電容器の外表面の少なくとも一部の全周に設けた金属網状電極と、該金属網状電極の内側に該放電容器と概略同軸に設けた内側

電極と、該放電容器内に充填され、誘電体バリア放電によってエキシマ分子を形成する放電用ガスからなる円筒状誘電体バリア放電ランプと、複数本の該円筒状誘電体バリア放電ランプを並行に配置して収納し、該エキシマ分子から放出されるエキシマ光を取り出す光取り出し窓を有するランプハウスと、誘電体バリア放電を行うための電源を備えた誘電体バリア放電ランプ装置において、隣接した該円筒状誘電体バリア放電ランプの間に概略V字型の光反射板を設けた構成したものである。

10 【0011】本発明の請求項2の発明は、本発明の請求項1の発明において、隣接した該円筒状誘電体バリア放電ランプの中心軸間の距離Xを該円筒状誘電体バリア放電ランプの直径Dの3.5倍以下に構成したものである。

【0012】本発明の請求項3の発明は、請求項1または請求項2のいずれかの発明において、該光取り出し窓に対面した隣接した該円筒状誘電体バリア放電ランプの円周の共通の接線を基準にした範囲Lを、該接線と該円筒状誘電体バリア放電ランプの管軸の両者に直角で、該光取り出し窓から遠ざかる方向に、該円筒状誘電体バリア放電ランプの直径の25%の長さの範囲としたとき、該V字型光反射板の頂点がLの範囲内に存在するように構成したものである。

【0013】

【作用】本発明の請求項1の発明においては、少なくとも外形が概略円筒状である光透過性の放電容器と、該放電容器の外表面の少なくとも一部の全周に設けた金属網状電極と、該金属網状電極の内側に該放電容器と概略同軸に設けた内側電極と、該放電容器内に充填され、誘電体バリア放電によってエキシマ分子を形成する放電用ガスからなる円筒状誘電体バリア放電ランプと、複数本の該円筒状誘電体バリア放電ランプを並行に配置して収納し、該エキシマ分子から放出されるエキシマ光を取り出す光取り出し窓を有するランプハウスと、誘電体バリア放電を行うための電源を備えた誘電体バリア放電ランプ装置において、隣接した該円筒状誘電体バリア放電ランプの間に概略V字型の光反射板を設けた構成にしたので、該円筒状誘電体バリア放電ランプから放出され、隣接する誘電体バリア放電ランプに向かうエキシマ光は、該概略V字型の光反射板で反射されて該光取り出し窓に向かうので、隣接する誘電体バリア放電ランプに直接入射して該金属網電極に吸収される事がなくなり、その結果、隣接する誘電体バリア放電ランプ間の直下の放射照度が十分に高くなり、高効率の誘電体バリア放電ランプ装置が得られる。

【0014】本発明の請求項2の発明においては、請求項1の発明において、隣接した該円筒状誘電体バリア放電ランプの中心軸間の距離Xを該円筒状誘電体バリア放電ランプの直径Dの3.5倍以下に構成したので、該光取り出し窓に入射するエキシマ光の量が増大し、請求項

1の効果に加えて、高放射照度の誘電体バリア放電ランプ装置が得られる。該概略V字型の光反射板を設けない場合には、隣接した該円筒状誘電体バリア放電ランプの中心軸間の距離Xを該円筒状誘電体バリア放電ランプの直径Dの3.5倍以下に構成すると、隣接する誘電体バリア放電ランプの金属網電極によるエキシマ光の吸収が著しく大きくなり、その結果、光取り出し効率の低下や、点灯時間の経過に連れての放射照度分布の不均一の拡大が発生するという欠点が著しく大きくなる。なお、この発明における該円筒状誘電体バリア放電ランプの外径Dとは、放電容器に装着した状態で測定された網状電極の厚みも含めた外径である。たとえば、直径d mmの素線を交差させた円筒状網を直径Z mmの放電容器に装着した場合、該導電性網状電極の厚みも含めたランプの外径Dは、素線の「網を作る時のよりによる重なり」の関係でdの4倍とZの和になる。

【0015】本発明の請求項3の発明においては、請求項1または請求項2のいずれかの発明において、該光取り出し窓に対面した隣接した該円筒状誘電体バリア放電ランプの円周の該光取り出し窓に対面した共通の接線を基準にした範囲Lを、該接線と該円筒状誘電体バリア放電ランプの管軸の両者に直角で、該光取り出し窓から遠ざかる方向に、該円筒状誘電体バリア放電ランプの直径の25%の長さとしたとき、該V字型光反射板の頂点がLの範囲内に存在するように構成したので、請求項1または請求項2のいずれかの発明の作用がより顕著に発揮される。なお、該V字型光反射板の頂点が該接線よりも該光取り出し窓側に延長されて存在しても、誘電体バリア放電ランプから放出されたエキシマ光が隣接した該円筒状誘電体バリア放電ランプに入射するのを防ぐ効果は大きくならず、むしろ、エキシマ光の取り出し効率が低下するという欠点が生じた。また、該V字型光反射板の頂点が該範囲Lよりも該光取り出し窓から遠ざかった位置に存在する場合には、誘電体バリア放電ランプから放出されたエキシマ光が隣接した該円筒状誘電体バリア放電ランプに入射するのを防ぐ効果が充分では無く、光取り出し効率の改善の効果が少なくなった。

【0016】

【実施例】本発明の第一の実施例である誘電体バリア放電ランプ装置の概略図を図1に示す。図1は、円筒状誘電体バリア放電ランプの管軸方向から見た断面を示した説明図である。本実施例における円筒状誘電体バリア放電ランプ1a、1b、1cは図5のランプの構成と同一であり、放電容器1は全長約250 mmの合成石英ガラス製で、外径16 mm、肉厚1 mmの内側管2、外径約26.5 mm、肉厚1 mmの外側管3を同軸に配置して中空円筒状にしたものである。外側管3は誘電体バリア放電の誘電体バリアと光取り出し窓部材を兼用しており、その外面に光を透過する金属網からなる外側電極4が設けられている。金属網の管軸方向の長さは、200

mmである。網状電極4は、直径0.15 mmのモネル線を軸方向に伸縮性のあるシームレスに編んだ円筒状網で、該円筒状金属網のなかに放電容器1を挿入し、ランプの軸方向に引っ張ることによって外側管3の外側に密接された網状電極4が形成される。従って、該円筒状誘電体バリア放電ランプの外径Dは、約27.1 mmになる。また、内側管2の外面にはアルミニウムの蒸着によって形成した光反射膜を兼ねた誘電体バリア放電用の内側電極5が設けられている。放電容器1の一端には、放電容器1の管壁を延長してゲッタ収容室6を設ける。このゲッタ収容室6にバリウム合金からなるバリウムゲッタ7を収納し、バリウムゲッタ7を高周波加熱してゲッタ収容室内にバリウムの薄膜を形成した。そして放電空間8には放電用ガスとして30 kPaのキセノンガスを充填した。

【0017】上記した円筒状誘電体バリア放電ランプ1a、1b、1cをランプハウス21内に収納した。ランプの冷却と光反射板を兼ねた冷却ブロック22と、開口部の大きさが170 mm×170 mmである合成石英ガラスからなる矩形光取り出し窓20と、側板23によって気密なランプハウス21が形成されている。冷却ブロック22に冷却用流体の通路28、29が設けられている。該円筒状誘電体バリア放電ランプ1aと1b、1bと1cの中心軸間の距離Xは60 mmである。したがって、隣接した該円筒状誘電体バリア放電ランプの中心軸間の距離Xと該円筒状誘電体バリア放電ランプの外径Dの比は、約2.2である。

【0018】円筒状誘電体バリア放電ランプ1aと1b、1bと1cの間に、アルミニウム板を折り曲げて構成した長さ170 mmであるV字型の光反射板11、13を設けた。V字型の光反射板11、13の頂点12、14は、該光取り出し窓20に対面した該円筒状誘電体バリア放電ランプ1a、1b、1cの円周の共通の接線PQR上に位置している。該円筒状誘電体バリア放電ランプ1a、1b、1cと矩形光取り出し窓20の間の空間26は、不活性ガス導入口24から注入した窒素ガスで充填されている。25はガス排出口である。該矩形光取り出し窓20の周囲には、開口部の大きさが170 mm×170 mmで、高さが15 mmである中空角柱状のアルミニウム板からなる光反射板27を設けた。

【0019】該円筒状誘電体バリア放電ランプ1a、1b、1cを、一個の電源10に並列に接続した。電源の出力を、周波数は約13 kHz、最大値、最小値間電圧で表したランプへの印加電圧は約12 kVにしたところ、該誘電体バリア放電ランプ1a、1b、1cは、それぞれ約50 Wで点灯し、キセノンのエキシマ分子から放射された波長172 nmに最大値を有する波長160 nmから波長180 nmの範囲の真空紫外線が放出された。該真空紫外線のうち隣接した誘電体バリア放電ランプに向かう部分は、V字型の光反射板11、13に反射

されて、光取り出し窓20に方向転換され、光取り出し窓20から放出される。すなわち、真空紫外線の取り出し効率が増大した。この場合、前記したとおり、該円筒状誘電体バリア放電ランプ1a、1b、1cと光取り出し窓20の間の空間26が窒素ガスで充填されているので、該真空紫外線は該空間26で吸収されない。従って、矩形状光取り出し窓20からは、該円筒状誘電体バリア放電ランプ1a、1b、1cから放出された該真空紫外線の合計が放出され、従って、該矩形状光取り出し窓20は実質的に矩形状の真空紫外線光源となる。

【0020】150mm×150mmのガラスを、空气中において、上記した誘電体バリア放電ランプ装置の光取り出し窓20と約3mm離して設置し、該誘電体バリア放電ランプ装置で真空紫外線を照射したところ、均一な放射照度が得られ、その結果、被処理物であるガラス以外の物質への該真空紫外線の照射が少ない状態で、ガラス上の有機汚染物を均一に酸化除去することが出来た。

【0021】本発明の第二の実施例を図2に示す。この実施例における円筒状誘電体バリア放電ランプ1a、1b、1c、光取り出し窓20の構成は、本発明の第一の実施例と同一であり、該円筒状誘電体バリア放電ランプ1aと1b、1bと1cの中心軸間の距離Xは60mmである。したがって、隣接した該円筒状誘電体バリア放電ランプの中心軸間の距離Xと該円筒状誘電体バリア放電ランプの直径Dの比は約2.2である。V字型の光反射板31、33は、ランプハウス21の壁の一部を兼ねており、一枚のアルミニウム板を折り曲げて構成したものである。また、V字型の光反射板31、33の頂点32、34の位置Yは共通接線PQRから5mm上であり、該V字型光反射板の頂点の存在が許容される範囲であるL内に存在している。なお、この実施例におけるLは6.77mmである。この実施例は、第一の実施例の利点に加えて、構造が簡単で、軽量であり、かつ、安価に製造できるという利点が生じる。

【0022】本発明の第三の実施例は、第一の実施例において、V字型の光反射板の代わりに、V字の先端を少し平たんにした図3に示した台形上の光反射板を使用したものである。この実施例においては、第一の実施例の利点に加えて、光反射板の加工が簡単であるという利点が生じる。

【0023】本発明の第四の実施例は、第一の実施例において、V字型の光反射板の代わりに、V字の先端近傍にまるみをもたせた図4に示した砲弾形の光反射板を使用したものである。この実施例においては、第一の実施例の利点に加えて、放射照度をより均一に出来るという利点が生じる。

【0024】

【発明の効果】以上説明したように、本発明によれば、次の効果を得ることが出来る。本発明の請求項1の発明

においては、少なくとも外形が概略円筒状である光透過性の放電容器と、該放電容器の外面の少なくとも一部の全周に設けた金属網状電極と、該金属網状電極の内側に該放電容器と概略同軸に設けた内側電極と、該放電容器内に充填され、誘電体バリア放電によってエキシマ分子を形成する放電用ガスからなる円筒状誘電体バリア放電ランプと、複数本の該円筒状誘電体バリア放電ランプを並行に配置して収納し、該エキシマ分子から放出されるエキシマ光を取り出す光取り出し窓を有するランプハウスと、誘電体バリア放電を行うための電源を備えた誘電体バリア放電ランプ装置において、隣接した該円筒状誘電体バリア放電ランプの間に概略V字型の光反射板を設けた構成にしたので、光取り出し効率高く、かつ、均一な照射面を得られる誘電体バリア放電ランプ装置を提供できる。

【0025】本発明の請求項2の発明においては、本発明の請求項1の発明において、隣接した該円筒状誘電体バリア放電ランプの中心軸間の距離Xを該円筒状誘電体バリア放電ランプの直径Dの3.5倍以下に構成したので、本発明の請求項1の発明の利点に加えて、高い放射照度が得られる誘電体バリア放電ランプ装置を提供できる。

【0026】本発明の請求項3の発明においては、請求項1あるいは請求項2の発明において、該光取り出し窓に対面した隣接した該円筒状誘電体バリア放電ランプの円周の共通の接線を基準にした範囲Lを、該接線と該円筒状誘電体バリア放電ランプの管軸の両者に直角で、該光取り出し窓から遠ざかる方向に、該円筒状誘電体バリア放電ランプの直径の25%の長さの範囲としたとき、該V字型光反射板の頂点がLの範囲内に存在するように構成したので、請求項1あるいは請求項2の発明の利点がより一層発揮できる誘電体バリア放電ランプ装置を提供できる。

【図面の簡単な説明】

【図1】本発明の誘電体バリア放電ランプ装置の実施例の説明図である。

【図2】本発明の誘電体バリア放電ランプ装置の他の実施例の説明図である。

【図3】本発明の誘電体バリア放電ランプ装置の他の実施例の要部の説明図である。

【図4】本発明の誘電体バリア放電ランプ装置の他の実施例の要部の説明図である。

【図5】円筒型誘電体バリア放電ランプの説明図である。

【符号の説明】

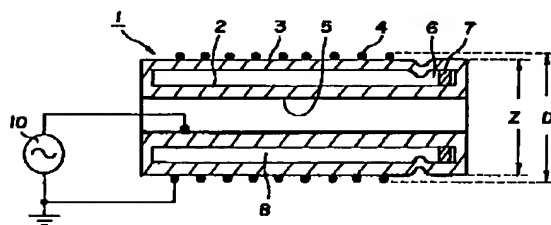
1	放電容器
1a, 1b, 1c	誘電体バリア放電ランプ
2	内側管
3	外側管
4	網状電極

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【図3】



【図5】



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